RANGE USE

H. KHATAB EL MOULAH FALD

Khatab K., El Moulah Fald, De Zborowski Isolde. 1993. Range use. In : Livestock production and sahelian rangelands potential: Republic of Sudan = Élevage et potentialités pastorales sahéliennes : République du Soudan. Darag A., Lamarque Georges. CIRAD-IEMVT - FRA. Wageningen : CTA-CIRAD-IEMVT, 20-22. ISBN 2-87614-088-8

For hundreds of years the nomadic herds of the Sudan made use of a minute proportion of the available feed resources. The majority of grasses were able to run to seed and provide a stock for regeneration in subsequent years. In the south of the area the ranker grasses produced large quantities of straw, of little nutritional value, little used by livestock, preventing access by small ruminants, and able to maintain a reservoir of parasites, especially ticks. The livestock owners combatted this problem by the simple expedient of setting fire to the vegetation, freeing enormous areas of useless bulk and encouraging early regrowth of perennial grasses, this being enabled by the mineral elements liberated by the fire. Firing generally took place in December or January, as the herds were leaving for the dry season pastures. Fires were not controlled, often caused considerable damage to the as yet unharvested crops and created conflict between livestock owners and crop farmers. The bare soil left by the fires was also susceptible to erosion, especially if the early rains arrived as violent storms.

To the north, fires were less frequent, mainly because the growth was (other than in exceptional years) inadequate to provide sufficient fuel for a good burn. Livestock, in effect, merely picked the choicest bits of the vegetation and, when the field layer was reduced to a poor quality feed of low nitrogen content they overcame the problem by browsing the protein-rich leaves of trees and shrubs.

During migration the major herds were preceded by scouts who sought out the best grazing and watering areas. Movements were more frequent where grazing or water was scarce. The provision of permanent water points can thus be seen as a major contributory factor, together with improvements in veterinary care, to the increase in livestock numbers and the consequent range degradation.

Stocking rates

The basis of an assessment of rangeland use is the number of animals that can be carried or are present per unit area in each ecological zone. A standard livestock unit (TLU or Tropical Livestock Unit) is generally assumed in order to calculate stocking rates, this being equivalent to an "average" cow of 1.0 TLU, a sheep or a goat being put at 0.1 and a camel at 1.2: this method has the merit of allowing stocking rates and carrying capacities to be expressed as a single figure but the unitary values ascribed to the different species are not very realistic.

Unfortunately, there is little real information on the distribution of livestock and the various "estimates" show enormous differences, depending on the source and the method used. Recent attempts to calculate animal populations do not cover large areas and are often very much at variance with the official data. Frequently quoted figures of 70% losses of cattle and 20-60% of small ruminants during the drought of the mid-1980s have not usually been taken into account in subsequent calculations of livestock numbers.

Two example will suffice to illustrate the nature of the problem. The first relates to a 1986 aerial census of the Gezira and the surrounding areas (Resource Inventory and Management 1987). A total of 50,570 km2 was included in the census, being virtually the whole of Gezira Province plus small areas of adjacent ones **(Figure 1)**. Censuses were repeated at 2-month intervals and the numbers of animals counted were adjusted upwards by 25% for cattle and 120% for goats to take account of the numbers under various type of cover at the time of the census. The results, even then, provide density estimates **(Table 1)** well below the official figures for the Province. Cattle and small ruminant estimates on open range areas were less than half the official figures and camels only one-eight of them: on irrigated areas, where densities are in any case much higher but more animals are in the open, the aerial census estimates were still well below the official figures.

Figure 1 - The zone covered by the aerial livestock survey in 1986

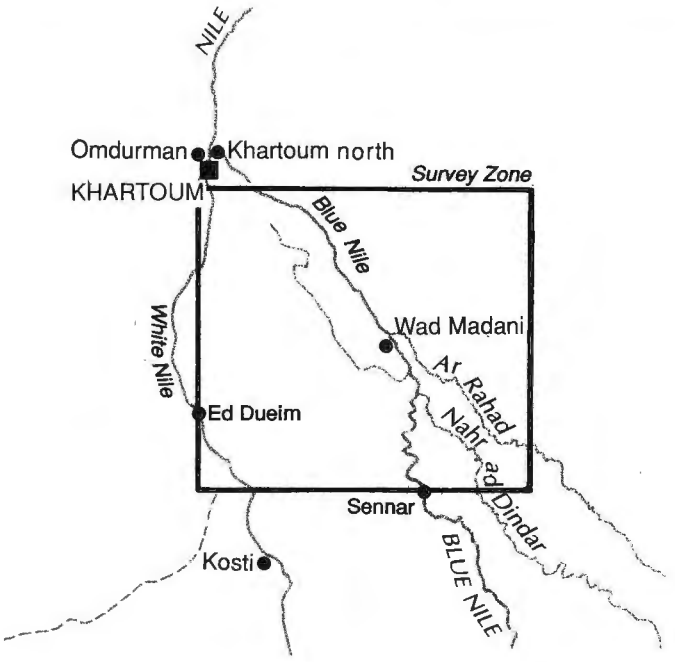


Table 1 - Livestock numbers and grazing pressure in Gezira Province

Parameters	Species			
	Cattle	Sheep	Goat	Camel
Official figures ('000)	647	1410	1411	167
Density (N°/km2)	25	55	55	8.5
Aerial survey (38,000 km2)				
February density (N°/km2)	9.6	15.8	25.1	0.7
April density (N°/km2)	11.9	40.9		0.8
Irrigated areas (12,500 km2)				
Average density (N°/km2)	20.4	70.9		0.4
Stock observed from the air (%)	48	45		12

A second example is provided by a survey carried out by OXFAM in Red Sea Province in March and September 1989. The figures for the period at the end of the rains in March, compared to those for September, are higher for sheep and goats (13-19% being in sedentary holdings), similar for cattle (with more than half close to the main towns) but very much lower for camels. Compared to the official figures the OXFAM estimates are much less, 50% for cattle and camels and 80-90% for small ruminants **(Table 2).**

Table 2 - Livestock numbers and grazing pressure in Red Sea Province Species

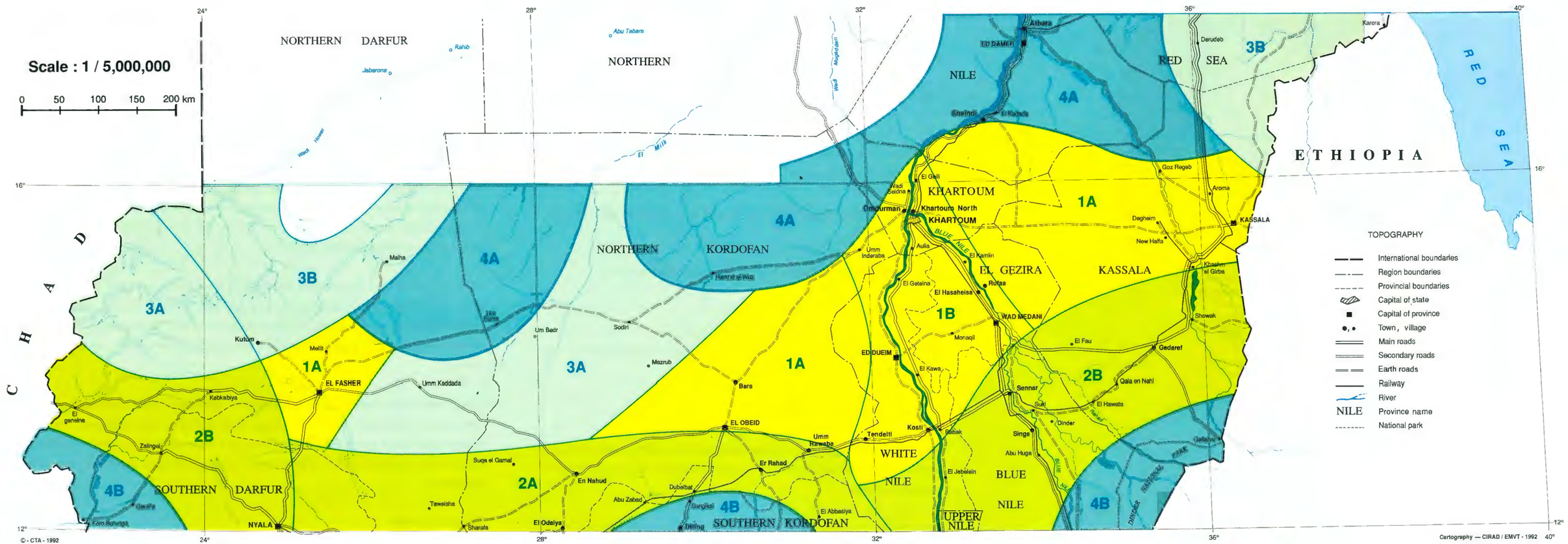
Parameters	Species			
	Cattle	Sheep	Goat	Camel
Official figures ('000)	47	260	549	110
OXFAM count ('000)	21-22	143-212	332-482	40-58
Ratio OXFAM/official	0.47	0.80	0.88	0.53

oxfam 1990

Official figures are now derived from the base established in 1976 (**Watson** et **al.**: Resource Management and Research 1976) and have been increased annually on assumed reproduction and mortality rates, except during the two worst drought years. Others sources assume even greater and totally unrealistic animal densities.

The number of animals present in the area covered by this atlas is shown in **(Table 3)** Official figures are usually given for administrative regions or provinces, of which some are only partially or even marginally represented in the present study area. In this last case the numbers have been recalculated on the basis of the proportional area. The stocking rates are provided for 1976 (the base year) and for 1986 (the latest year for which official figures are available). The very large and

RANGELAND UTILIZATION AND DEGRADATION



1A 1B Degraded areas

2A 2B Endangered are as

3A 3B Slighty overgrazed rangelands

4A 4B Intact rangelands

apparently unexplainable differences are obvious, as for example a general increase of 20-30% but an increase of 50% for the Gezira and 115% for Northern Darfur. Both these last areas are totally included in the mapped area and proportional calculation errors can thus be excluded. In spite of statements that regular quotients are applied across the board this is obviously not the case.

A second method of calculating the pressure on the feed resources is one that takes account of the amount available (see section on Primary Production). Domestic herbivores are assumed to eat dry matter equivalent to 2.5% of their live weight every day, or just over 6 kg per TLU. The whole of primary production is not, however, available to animals, in part because some of it is inedible and in part because some is inaccessible. In addition, total consumption of plant material would lead to the death of perennial plants and loss of the seed bank in annuals. Most reccommendations of best use are that actual consumption should be one-third to one-half of the feed on offer: this then allows, at the same time, the plants to survive and regenerate and the animals to select the best of what is available.

Table 3 - Livestock numbers and grazing pressures in the Sudan

Official livestock number 1986 ('000)					Livestock in mapped area		Density (TLU/ km^2)	
Province	Cattle	Sheep + goats	Camels	Mapped area ('000km^2)	%	TLU ('000)	RIM 1986	RMR 1976
Red Sea	3	40	5	20	5	13	0.65	1.03
Nile	45	512	54	85	80	161	1.90	1.50
Kassala	826	2,984	651	124	100	1 906	15.37	12.90
Gezira/Khartoum	720	3,696	183	44	100	1 309	29.75	19.53
Northern Kordofan	1 204	4 941	976	216	100	2 869	13.28	10.07
Northern Darfur	1 165	3 107	259	173	100	1 786	10.32	4.79
Southern Darfur	878	702	41	43	25	997	23.19	18.97
Southern Kordofan	283	273	-	20	15	310	15.50	11.84
Blue Nile	635	1 091	24	44	55	773	17.57	14.35
White Nile	2 008	3 370	89	39	100	2 452	62.87	49.77

Source: ??

On the basis of a feed availability of 16 ± 2 kg per TLU per day it is possible to arrive at a hypothetical carrying capacity for the area studied, and compare this to current stocking rates **(Table 4)**. The figures for carrying capacity for the Northern and Eastern regions are obviously notional as almost all the animals are concentrated on the Nile in the first area and are very unevenly distributed in the second case, most being in Red Sea Province. They are more generally relevant for the other areas and show that stocking rates are not too high in Darfur, somewhat high in Kordofan and excessively high in the Central Region. In this last area, livestock do not subsist on the range alone and receive some form of supplementation. It might also be deduced **(Table 4)** that official figures for livestock are probably about 20% higher than is actually the case.

Table 4 - Actual and potential range stocking rates (TLU/km2) in major regions of the Sudan

Region	Stocking rate		
	Official figures	Aerial census	Calculated carrying capacity
Northern	1.89	1.50	1.1- 1.3
Eastern	13.33	7.42 ?	9.0-11.5
Central and Khartoum	35.70	27.02	11.6-14.8
Kordofan	13.47	10.22	8.7-11.0
Darfur	12.88	7.60	9.5-12.1

Source: ??

The feed situation

The use of feed resources is related both to the types of animals which feed on them and to their movements. Livestock distribution patterns show that camels and small ruminants are the dominant species in the north, while cattle are concentrated in the south. The division is not, however, totally rigid and many areas are used alternately by cattle and camels, each of which is able to occupy a particular niche at different times of the year. In addition, some areas in a particular zone may be reserved for one species, for example cattle in those areas with a good field layer, or those close to water, while the more difficult areas are grazed by the other species.

The mobility of the herds, that is to say the transhumant and nomadic practices, helps greatly in overcoming the loss in feed value of the natural resource during the dry season. This fluidity does, however, have disadvantages in the modern world: for example, in the availability of medical and veterinary services, the provision of children's education, and the "rational organization" of grazing regimes and water supplies. The advantages, from the owners'point of view, are that they and their animals escape from the plague of insects and the mud that are the normal consequences of rain in the southern areas and are able to use the northern pastures which would otherwise be wasted, and save the southern ones for dry season use. Mobility also allows, to a considerable extent, animals to find a diet of at least fair nutritional value throughout much of the year. This freedom of choice is, however, being more and more restricted by legislation on rights and times of access to resources which have always been subject to traditional if more flexible arrangements.

From the foregoing it is evident that each major ecoclimatic zone needs to be examined individually in relation to feed supply and animal nutritional status.

The desert zone

In the desert, feed resources are both widely scattered and not always available when most required. The *"gizu"*, for example, is expected to occur in one out of five years but there was apparently none at all between 1965 and 1974 and in 1975 it was limited to very restricted areas. In the 15 years following, there were four "gizu" years but the areas where it occurred were such that only camels and small ruminants were able to take advantage of it. While the *"gizu"* is an essential feed resource, its impact at national level does remain somewhat limited.

Administrators as well as livestock owners appreciate the *"gizu"*, however, as tribal quarrels are fewer in *"gizu"* years. The Kababish are the people who traditionally make most use of the *"gizu"* and are prepared to travel as much as 1,000 km in search of it. Because camels, in particular, do not require free water when on "gizu" grazing these long distances are not as taxing as might first appear. Absences from the home base and its water supply of as long as eight months are possible in exceptional years. The herdsmen get their liquid requirements from camel milk but they also pay a penalty, in terms of their own health, in order that their stock can benefit: the cold nights of the desert winter result in bronchitis, pneumonia and rheumatism.

The fossil valleys of the Nile are a more reliable source of feed in the desert. In particular they provide a sure base from which forays in to the desert to take advantage of ephemeral feed supplies can be made, or act as staging areas on the routes to the few desert oases. In some years, individual storms of 60 mm of rain or more can lead to a sprouting of vegetation at the bases of hills or in small run-on areas. Camel herds then sally 100-200 km in search of these from their bases along the Nile, or in the Wadi el-Milk and the Wadi Howar, to which they return when the feed is exhausted. These relatively favourable wadi areas are occupied every year in the hope of such temporary supplies of feed but, in their absence, are themselves becoming more and more degraded.

The hyper-arid zone

The hyper-arid zone can only be used in the rains. The area is almost exclusively used by camels and small ruminants, which need watering less frequently than do cattle. Some *"hafir"* and boreholes have been provided to extend the area that can be used. The potential carrying capacity has been estimated at 26 TLU/km2 (**Harrison** and **Jackson** 1958) on those areas which are on Basement Complex soils but it has to be assumed that this figure is valid only for the 4-8 month period when it is possible for the area to be used. A primary production of 600 kg/ha is implied by such a carrying capacity, a biomass which can only be achieved in areas receiving more than 200 mm of rain. Such relatively high carrying capacities can apparently only be maintained by camels which make efficient use of the browse layer.

The annual grasses in this zone have a short growing period that is mainly confined to August but at this time they provide a feed of excellent nutritional value. Maximum biomass is attained at the end of September or in early October. Temporary pools are formed during the short rainy period and some of the deeper ones contain water as late as November and December. The dried-out grasses continue to provide feed and are grazed until drinking water is no longer available. Much of the brittle straw, however, simply breaks off, falls to the ground and is eaten by ants or decomposed by bacteria and fungi, the remainder rotting away at the advent of the next rains. Much of the seed stock is dispersed over a wide area, leading to a certain homogeneity of vegetation types in the zone. The primary production from this seed bank in a particular year is greatly dependent on the amount and distribution of rainfall.

The eastern slopes of the Red Sea Hills are a better grazing area than most of the remainder of the hyper-arid zone because the steep valleys into which rainfall is channelled provide a good feed resource. The pattern of use is generally similar to that of the rest of the zone and there is considerable use of browse. Some use by cattle is possible, however, particularly in the Ethiopian frontier areas which are accessible from bases that are only a short distance away.

In contrast, the very dry areas closer to the Nile and Atbara Rivers are less useful as pasture areas as the outlying clay areas do not constitute a feed reserve for animals which may venture far to the north. The feed potential of valleys themselves is greatly reduced as the dense system of cultivation impedes free access.

The arid zone on sands

The Sahel zone is an important grazing area for both cattle and camels. The former use it during the wet season and feed mainly on the field layer. This use is complemented by camels which are present mainly during the dry season and make more use of the browse layer. The installation of many permanent water sources in this zone has encouraged a semi-sedentary production. There can be little doubt, however, that some of these water points have been installed other than for sound economic and ecological reasons. This has allowed permanent use of large areas, which rationally should be used only seasonally, with vast bare and degraded areas being the result.

A single large capacity water source allows an area within a radius of 20-30 km to be permanently grazed. By the end of the dry season there is absolutely no vegetative cover left and the bare soils are susceptible to both water and wind erosion. Annual grasses are not allowed to set seed and there is thus no seed bank for subsequent years. The small stocks that remain are often lost if the seeds germinate in response to an early rain which is followed again by a long dry spell. The sparse and poor quality vegetation that does establish itself forms discontinuous patches and even these are becoming more rare with the passage of time. The once-valuable browse layer is also under attack to provide fuel wood for the expanding sedentary populations, further aggravating the effects of wind and providing little hindrance to wind-blown sand. Attempts to establish "green belts" around the major villages and towns have rarely been successful and in addition are extremely costly.

The arid zone is one in which there once existed a complex equilibrium between plants and animals. Too light a use could result in there being sufficient dry material to maintain a fire, destroying the dry season potential. Too heavy use, paradoxically, might have the same effect. A series of bad years could lead to an apparently spectacular decline in the feed value of an area but a run of good years served to restore the balance. Heavy settlement and increased numbers of animals have destroyed this natural system of checks and balances.

The sandy areas of the arid zone are also an important producer of gum arabic from *Acacia senegal*. Most gum is produced if trees are allowed to mature to 6-8 years before any harvest is taken, are tapped only during the dry season, and the old wood then pruned to encourage new

growth. Increased population pressure, ignorance of the tree's ecological requirements, the loss of traditional ownership rights to trees, the high price of gum on the world market and the lack of other sources of cash have had serious negative effects on the long term productivity of this resource. Regeneration is reduced (and attempts to encourage it have not been very successful) and the areas laid bare are now largely covered by *Calotropis procera*, always a sign of degradation and a plant of practically no feed value.

Present trends in national policies and the world market for gum arabic may yet provide a reprieve for *Acacia senegal*. Heavy taxes are charged on export and the numerous artificial substitutes now available have led to lower returns. In addition there is not an unlimited market for the product and this seems to be at saturation point. The "gum arabic industry" is essentially one of opportunistic gathering, it is badly organized, returns are at best not very good and additional costs of transport and taxes are a disincentive to its production. This is all to the good of the range and to livestock production.

The carrying capacity of this Sahel zone has been variously estimated at 78 TLU/km2 (**Harrison** and **Jackson** 1958) and 50 TLU/km2 (Hunting Technical Services 1974). It would appear that even the lower of these figures, if the area were to be grazed for six months (equivalent to a primary production of 1,500 kg/ha), is too high for the zone as a whole but would apply only to the most productive areas. The zone is in fact grazed throughout the year and even the current stocking rate of 11-12 TLU/km2 is leading to more and more degradation.

Dry zone on clay

The Butana has for long been considered to be a vast grass plain but the marked contrast that existed between this and the more wooded areas to the west is now less obvious. As a consequence of the loss of woody cover on the sands the principal difference between these and the clays is the distribution of the shrub layer. In Kordofan the shrub layer is somewhat more evenly spread over the whole area while in the Butana it is more or less confined to the drainage lines and some run on areas. Erosion in the clay plains often commences insidiously by the appearance of bare arcs in the field layer: water collects along these arcs which benefits the plants on the down slope, while at the same time the water-borne soil particles are deposited above. Plants that receive less water begin to disappear, and the arcs creep up the barely perceptible slopes to occupy the empty space.

It is evident here, also, that over use destroys the delicate balance that exists in these fragile ecosystems. The progressive loss of these vegetation bands results in poor water infiltration with consequent greater and faster run off. On the resulting denuded areas the seed reserve is carried away by the first rains and has no chance to germinate. Cattle and sheep, the principal grazing animals, are mainly responsible for this type of degradation. This was recognized many years ago when it was proposed (**Harrison** and **Jackson** 1958) that the clay plains be reserved for use by camels, especially in view of the fact that, needing watering only at intervals of 4-6 days they are much more efficient users of the whole area.

In fact, **Harrison** and **Jackson** (1958) suggested a carrying capacity of 31 TLU/km2 for the clay plains or only about 40% of that they suggested for sand in the same climatic belt, thus attempting in some measure to acknowledge the extreme fragility of the clay plain environment. This area was also at risk, at least until the 1969s, from the frequent dry season fires. A carrying capacity of 31 TLU/km2 implies a primary production of 740 kg of dry matter eaten over a five-month period but this recommended rate is certainly exceeded at the current time over much of the area. The Butana is a desolate sight these days with a few scattered dead and moribund stumps remaining in a vast sea of bare earth.

Semi-arid zone and sand

This is an area that is permanently occupied by livestock and at the same time the one which has suffered more than any other from the spread of cultivation. Between 1960 and 1987 it was estimated that more than a third of the national grazing resource had been lost, some from desertification in the north but most from advancing cropland in the south. The annual increase in cultivated area on semi-arid sand and clay combined is of the order of 200,000 ha. The pastoral response to this loss has been a systematic annual transhumance to the Bahr el Ghazal whereas in earlier time such a move was only made in very exceptional years.

The short time which animals can now spend in the northern areas means, of necessity, that the southern pastures are grazed much earlier than they used to be. Early grazing means that there is insufficient fuel in the later dry season to burn to encourage new growth. In addition, the traditional control of a group over times and numbers of stock grazing, has been lost and the situation is now often chaotic. Not only rights, but also the resource itself, are being eroded and it is clear that the composition of the vegetation now differs greatly from that described in the 1950s and 1960s. These negative effects are a further reason for attempting to re-established some rational form of control.

Conflicts between herders and crop farmers are more frequent and often more violent than heretofore. Part of the reason lies in the greater area under cultivation but the political problems in the south of the country can also be considered to be a contributory factor. Animals are driven more and more by their owners on to cropped areas, often by night. This means the problem is assuming a more fundamental aspect, it being not only over grazing and access but over ownership of the land itself. The traditional pastoral tribes consider they have historical rights to much of the area but the settled farmers consider the pastoralists as intruders, coming from afar but coming earlier and staying later than was the situation a few years ago.

Government response, faced with this conflict and with the lack of feed resources, has been to attempt to establish ranches or grazing blocks and to limit mobility to short distance transhumance to well-defined areas. Results do not seem to have been very good on such an area of 400,000 ha in Darfur and have been even less encouraging, some even say amounting to total failure, in Kordofan. In spite of this the same line is still being pursued by Government.

Another factor is the tendency of pastoralists to settle. This is in particular the case for those who have lost a major part of their holdings and who no longer see the advantage of making long treks when they can be more comfortably settled near a permanent source of water. Other advantages arising from all or part of the household settling in one place include education for the children, medical services and the proximity of market facilities. The sedentary part of the family often cultivates a small plot, but usually with little enthusiasm as cultivation is viewed as being much harder work than herding, to complement the products of the herds and flocks.

Semi-arid zone on clay

If there are problems on the sandy areas of the semi-arid zone, it seems they are even more pronounced on clay. Access to water along the rivers is almost impossible in view of the intense cultivation, even though in theory livestock corridors have been delineated through these areas. In reality these corridors are far too narrow to allow of sufficient feed for animals on their way to and fro and throughout the year. The herdsmen accuse the cultivators, who indeed tacitly admit to it in order to try and limit damage to their crops, of moving the boundary markers, thus making an already inadequate provision even more restrictive. Farmers who themselves now own livestock believe they have further cause for complaint and accuse the nomadic livestock of bringing in disease and weed seeds. A few farmers believe this to such an extent that they remove dung from their fields to prevent weed growth even though they are aware of the benefits it has as a fertilizer. Conflicts are now sometimes so violent that the army has had to intervene.

Attemps to redress the situation and provide some rational solutions seem to have had even less success on the clay plains than on sands in Darfur and Kordofan. As an example, an area of 200,000 ha designated as a grazing reserve was quickly turned into a mechanized farming scheme when it proved impossible to manage livestock there. On the other hand, pastoralists have little respect for the prohibitions on grazing of domestic livestock in the Dinder National Park. They consider this area, just as they do the areas recently occupied for cultivation, as their traditional grazing fief and accuse the authorities of neocolonialism in attempting to deprive them of these ancient rights.

Even though the number of nomadic herds is being reduced there has been no reduction in livestock numbers and new production systems are evolving. Herd and flock output shows increases in line with improved management, in particular as animals are sold at younger ages. Sedentary farmers buy young sheep from the traditional owners, to fatten them on crop or agro-industrial by-products and then send them by lorry to Khartoum where they find a ready market. On the major agricultural schemes, most farmers now have more than just a donkey or two and a few animals used to provide power: a growing number now keep, on a more or less commercial basis, some 10-20 cattle and as many as 50 small ruminants. The animal are penned at night and daily herding is under the control of a hired herder, who is mainly paid in kind but who also has some of his own animals in the herd. The major feed resource is the crop residues and the weedy growth on canal banks.

In the Gezira there is more of this latter kind of feed available, particularly between July and October. From November to February, sorghum stubbles and residues and groundnut haulms provide the main feed. In March there are limited areas of wheat stubble to graze, with some cotton stalks from mid-April, but in general the feed situation is at its most critical in the period March-June. At this time it is usual to feed some stored straw and provide some supplementary concentrates but weight losses are still the price that has to be paid and in bad years the death toll mounts. A recent development is that of cooperative milk production, local cattle being crossed with Friesians, especially in proximity to the larger villages in the main irrigated areas.

A further development is investment, in the economic sense of the word, in large scale livestock production. The wealthier farmers build up herds of as many as several hundred head. The younger male members of the family assume responsibility for a seasonal transhumance to the north. In this way the home-based feed supply of the irrigated lands is available in the dry winter season where there is plenty of water, in what for traditional pastoralists is almost the most difficult time of the year. These new "pastoralists" are much better organized than traditional owners, partly because of these advantages but also because of their knowledge of and their advantageous position in relation to the major markets.

The Darfur mountainous area

This is not a homogeneous area in terms of climate and resources. It is, however, a clearly differentiated and partly self-contained production system that makes full use of the resources of Jebel Marra and the various valleys to the west and south which are a prime dry season resource. Livestock owners here are relatively well off: those in the north of the area are estimated to have the equivalent of 35 TLU for an average household of seven people, and those to the south may have double this number. These holdings are 20-40% greater than the national average for the same latitude band. Agriculture has not expanded to the same extent here as farther to the east and traditional grazing areas have not suffered the same degree of encroachement, except along the new highway from Nyala to El Geneina.

The political frontier with Chad is just that. There is no physical or natural barrier to free passage and Darfur has always been influenced to some extent by the west, the Fellata herders with their Um Bororo cattle being a case in point. The dry season transhumance is not necessarily directly south to the Bahr el Arab and many herds have traditionally moved in a south-westerly direction into Chad and the Central African Republic. Insecurity in Chad in recent years has proved an impediment to this latter system and, indeed Darfur now finds itself an immigration zone for herds attempting to avoid the conflict there.

The reminder of Southern Darfur is also relatively better off than most of the northern pastoral areas, in terms of rainfall and soil and feed resources. As a result dry season movements, even here, are not so long in distance or in time as they are in many other areas.

Southern Darfur, whether it be Jebel Marra or the area in general, is far from totally exempt of the effects of climate. The drought of recent years has affected the area to a considerable extent with the worst affected areas being those on volcanic ash and on lithosols. Except close to the towns and large villages, however, the woody vegetation remains relatively intact. The browse layer along the major valleys (including the Wadi Howar) and on the higher points of Jebel Marra also remains in better conditions than elsewhere. It should also be possible here to restore the field layer within a reasonable period of time.

Map summary

An attempt has been made on the pastoral map to include data relating both to current stocking rates and to the conditions of the range itself. The result has been the identification of 15 zones which largely represent four major conditions, all presenting a somewhat sombre prognosis for the future. These can be described in decreasing order in relation to the problems they are facing.

Very degraded areas

This is the heart of the central area, from El Obeid to Kassala. The situation here remains critical, not only because the range resources are excessively degraded but also because the number of animals is still very high. Recovery of this area is not possible in the foreseeable future.

Two major areas can be identified:
Type **1A** pastures which comprise three discontinuous areas, one on clay and two on sand. One sandy areas is around El Fasher and the other in east-central Kordofan. In all three areas the degradation is man-made rather than being a result of climatic change, and the situation is unlikely to improve while stocking rates remain high.

Type **1B** comprises the plains close to the Nile, affected by the major irrigation schemes which, in fact, are also the principal feed resource. Stocking rates are thus far in excess of the capacity of the natural rangelands but present stocking levels will only be maintained if adequate crop residues and some sort of concentrate feed can be made available.

Areas at risk

These areas include almost the whole of the semi-arid zone. Their original production levels have been reduced mainly as a result of overgrazing, which in itself has resulted in part from animals coming here from the already denuded zones just described. It is again possible to identify two major areas:

- area **2A** is the semi-arid sandy zone which has had an influx of animals that in the past grazed farther to the north and which have added further impetus to a zone already at internal risk from drought. The major stock routes also cross this area and many livestock owners are turning to cultivation to provide an additional source of income and compensate (-) for (-) reduced (-) animal productivity. The relict natural vegetation requires urgent measures to conserve it if it is ever to be rendered productive again;

- the areas of **2B** in Darfur and on the clay plains are still not so heavily stocked as to have caused excessive degradation. The current trend, however, is of more and more cultivation and a concentration of animals on areas of poor quality grazing.

Lightly overstocked areas

These hyper-arid and arid zones have mainly suffered as a direct result of climatic change. They are now, nonetheless, having to support livestock numbers well in excess of their carrying capacity. Again there are two areas:

- **North Darfur** and **western Kordofan** designated **3A;**

- the arid zones of **Northern Darfur** just to the south of those in **3A**, as well as the **Red Sea Hills** in the **east**, both being noted as **3B.**

Areas not seriously affected

These are in general the areas where range production has yet to be reduced. The two major reasons and the zones that they represent are:

- most of the semi-desert area, classed as **4A**, which had to be abandoned at the height of the drought. It is now virtually inaccessible because of the denuded areas to the south of it and prospects for recovery are reasonably good;

- the mountainous areas **(4B)** have been less affected by climatic change than elsewhere and have been spared to some extent because they are relatively difficult of access. There is still risk of devastating fires in these areas. Some parts of this unit are partially protected (Dinder National Park) and others are of relatively little value as pastures (Nuba Mountains).

BIBLIOGRAPHY

1. LIVESTOCK POPULATION

Gezira Study Mission . Appendice on agronomy, mechanization and livestock. 1966. 260 p.

Gezera Livestock Integration Study. Devco Ireland. 1987.

Government of Kordofan Region - Inventory of animals at El Obeid Town and surrounding villages, to assess requirements of grown fodder, concentrates and water supply. Department of Planning and Economy and the Administration for Natural Resources. 1985. (in Arabic).

MAFNR (Ministry of Agriculture, Food, and Natural Resources) - Sudan national livestock census and resource inventory. The results of an aerial census of resources in the Blue Nile Province, Vol. 10. The results of an aerial census of resources in Sudan, Vol. 31. Khartoum, MAFNR, 1977.

MFEP (Ministry of Finance and Economic Planning) - Statistical abstract. Khartoum, Department of statistics. 1983.

Oxfam integrated livestock survey of Red Sea Province. ERGO, 1990.

Sudanese Meat and Livestock Marketing Corporation - National herd distribution. Khartoum, Sudanese Meat and Livestock Marketing Corporation, 1981.

Watson R.M., Tippet C.I., Rizk F., Jolly F. Beckett J., Scholes V, Casbon F. - Sudan national livestock census and resource inventory.
Khartoum, Veterinary Research Administration, 1977.

2. RANGELAND UTILIZATION

Abu Sin M.E., El Sammani M.O. - Socio-economic aspects of integrated resource management, with special reference to the forest resources of Kassala Province, Eastern region, the case of the Rawashda and Wad Kabu Forests. Government of the Democratic Republic of Sudan, Netherland Government, FAO, 1986.

Babiker A.A., Musnad H.A., Shaddad M.Z., Wood resources and their use in the Nuba Mountains. In: DAVIES H.R.J., ed - Natural resources and rural development in arid lands: case studies from Sudan. Tokyo, United Nations University, 1985. P. 30-59.

Blake H. - Policy considerations in the production and marketing of gum arabic in Sudan. Khartoum, USAID. 1983.

Blunt H.S. - Gum arabic. Oxford University Press, 1926.

Boudet G., Delpiano P.G., Abdallah A. - Ecological management of arid and semi-arid rangelands in Africa, and the Near and Middle East. (EMASAR-Phase II). Vol. VIII Sudan. Proposals for grazing land development. Rome, FAO, 1978.

Briggs J. - The human and physical environments come together: a case study of the Gummuiya scheme. In: DAVIES H.R.J., ed - Rural development in White Nile Province. Tokyo, United Nations University, 1986. P. 114-136.

Davies H.R.J., ed. - Rural development in White Nile Province, Sudan.
Tokyo, United Nations University, 1986.

El Arifi S.A. - Development strategy for the arid zone of western Sudan. University of Khartoum, Department of Geography, 1978.

El Hassan, Ahmed Mohamed - The environmental consequences of open grazing system in the central Butana. M. Sc. Thesis, University of Khartoum. Institute of Environmental Studies, 1981.

FAO - Report on the workshop on livestock policy, range and feed utilization guidelines for drought-prone African countries, Khartoum, Sudan, 1985.

GITEC - Gum arabic development. Unpublished final report for EEC, 1980.

Haaland G. - Social organisation and ecological pressure in southern Darfur. In: HAALAND G., ed. - Problems of savannah development: the Sudan case. University of Bergen, Department of social anthropology, 1980. P. 55-105. (Occasional paper)

Haarmann V. - Naturpotential und Grenzen der Landnützung im Südsahel des Südostlischen Jebel-Marra Vorlandes. Hamburg, Mensching, 1987.

Harrison M.N. - A report on a grazing survey of the Sudan. Khartoum, Ministry of Animal Resources, 1955.

Seil El Din A., Obeid M. - Ecological studies of Sudan IV. The effect of simulated grazing on Acacia senegal (L) Willd seedling.
J. appl. Ecol., 1971, 8 (1) : 211-217.

3. RANGELAND DEGRADATION

Ball J. - Problems of the Libyan Desert.
Geogrl. J., 1927, 70 : 21-38, 105-128, 209-224.

Ballal A.I. - Suffering from neglect: development in Darfur.
Sudanow, 1987, 12 (6-7) : 23-26.

Bari E.A. - Sudan. In: HEDBERG I.O. - Conservation of vegetation in Africa South of the Sahara. CAETFAT Symposium.
Acta Phytogeographica Suecica, 1968, 54 : 59-64.

Cloudsley -Thompson J.L. - Human activities and desert expansion.
Geogrl. J., 1978, 144 : 416-423.

El Sammani M.O., ed. - Kordofan rehabilitation and development strategy. 3 Vols. Khartoum, Sudan government/UNDP, 1986.

Euroconsult - Reassessment rehabilitation programme, Kordofan and Darfur: final report to the Ministry of Finance and Economic Planning, Republic of Sudan. Arnhem, The Netherlands, Euroconsult, 1986.

Government of Eastern Region - Indicators of range problems of eastern region. Department of range and pasture, Seminar for combating desertification, 1983. (in Arabic).

Government of Kordofan Region - The experience of Kordofan region with desertification and drought. Department of planning and economy (MEF) and project operation unit (MANR). 1985.

Government of Kordofan Region - Desertification and drought in North West Kordofan (Sodiri). Department of planning and economy, 1985. (in Arabic).

Hellden U. - Desertification monitoring: is the desert encroaching?
Desertification Control Bulletin, 1988, 17 : 8-12.

RANGE USE (CONTINUED)

Ibrahim F.N. - The problem of desertification in the Republic of Sudan with special reference to Northern Darfur Province.
Khartoum, Science Research Council, 1978. (Science Research Council Monograph N_8).

Jefferson J.H.K. - Soil conservation in the Sudan. Development and projects. Khartoum, Ministry of Agriculture. 168 p.

Lamprey H.F. - Report on the desert encroachment reconnaissance in Northern Sudan. Nairobi, United Nations Environmental Programme. 1975. 14 p.

Manger L.O. - The sand swallows of our land - over-exploitation of productive resources and the problems of household viability in the Kheiran - a Sudanese oasis. (Department of social anthropology occasional paper n_24). University of Bergen. Department of social anthropology. Bergen, Studia University Bookstore, 1981.

Stebbing E.P. - The creeping desert in the Sudan and elsewhere in Africa. Khartoum, Sudan Government, 1953.

Swift J. - Rehabilitation and long-term development for pastoralists in Red Sea Province, Sudan. Khartoum, UNICEF, 1986.

Trilsbach A. - Desertification and rural changes in central Sudan. Ph. D. Thesis. University of Wales, Swansea, 1983.

Sudan, Ministry Of Food, Agriculture And Natural Resources - Rehabilitation of range resources and livestock production improvement: Democratic Republic of the Sudan.
United Nations Sudano-Sahelian Office, 1979. 8 p.

United Nations, Sudano -Sahelian Office, UNSO - Desertification control and range management: an approach to the protection and further development of the range resources in western Sudan.
Findings of the UNSO rangeland mission, 16 May-3 June 1981. UNSO/DES/INT/81/002.
United Nations Sudano-Sahelian Office, 1981. 60 p.